



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

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REPLY TO  
ATTN OF: GP

TO: USI/Scientific & Technical Information Division  
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for  
Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No. : 3,491,335

Government or  
Corporate Employee : GOVERNMENT

Supplementary Corporate  
Source (if applicable) : NA

NASA Patent Case No. : ~~XLA-01926~~ XLA-01926

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

Yes  No

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

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Enclosure

Copy of Patent cited above

14

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Jan. 20, 1970

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3,491,335

EXCESSIVE TEMPERATURE WARNING SYSTEM

Filed Nov. 26, 1968

2 Sheets-Sheet 1

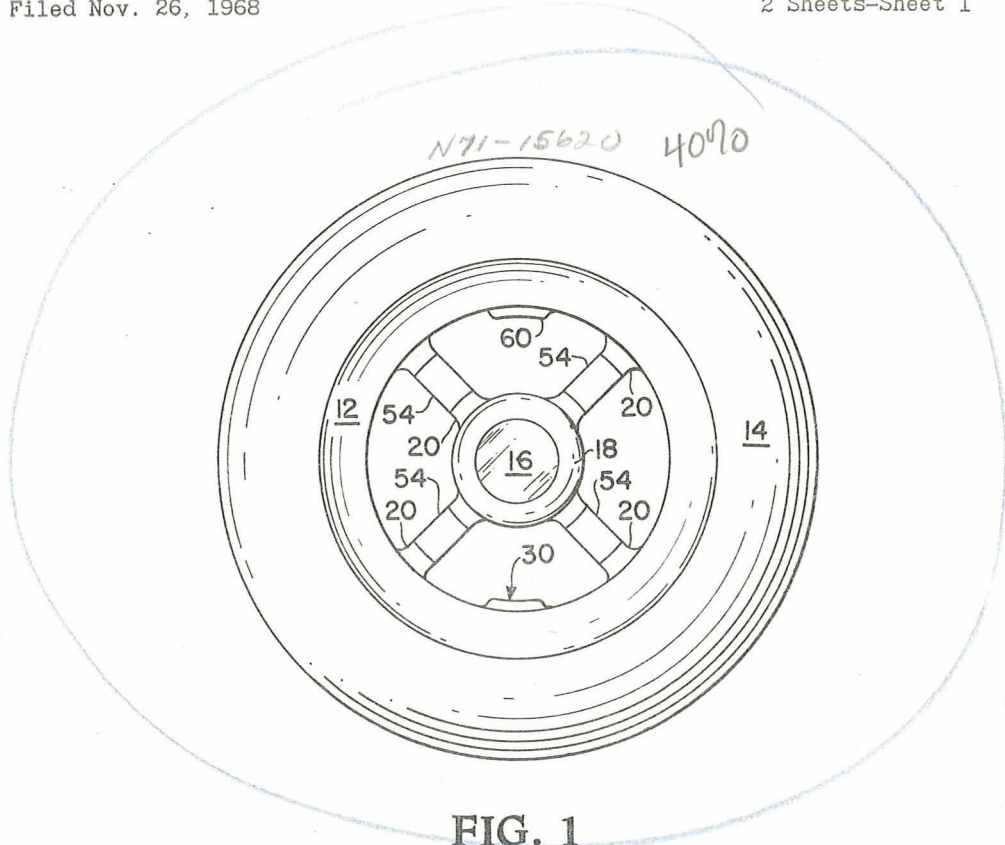


FIG. 1

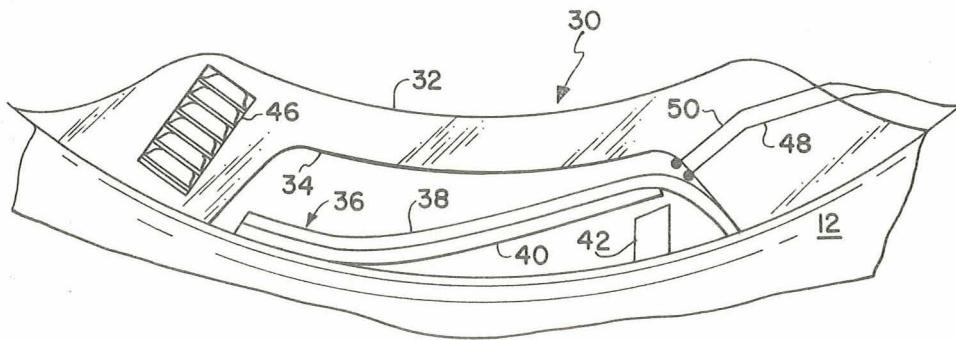


FIG. 2

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ACILITY FORM 602

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EXCESSIVE TEMPERATURE WARNING SYSTEM

Filed Nov. 26, 1968

2 Sheets-Sheet 2

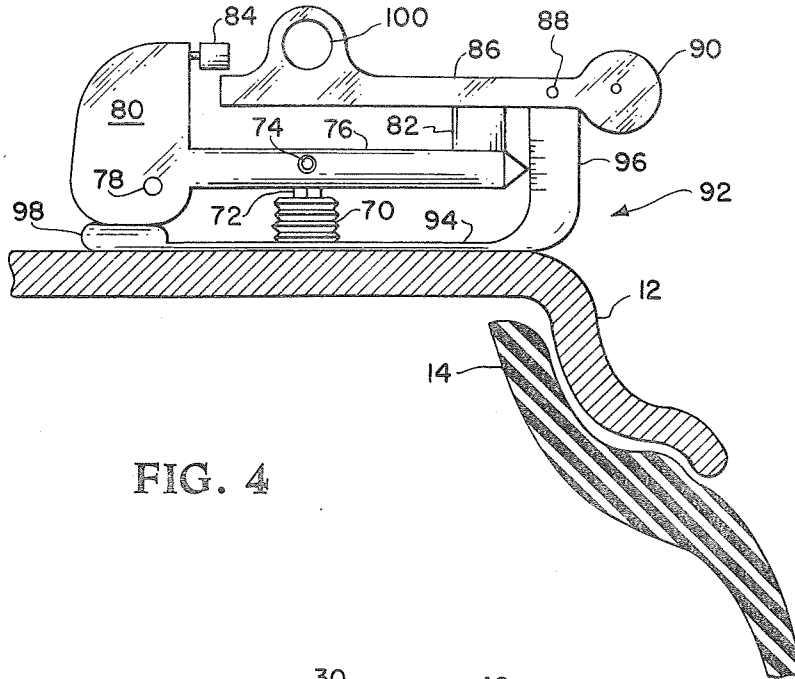


FIG. 4

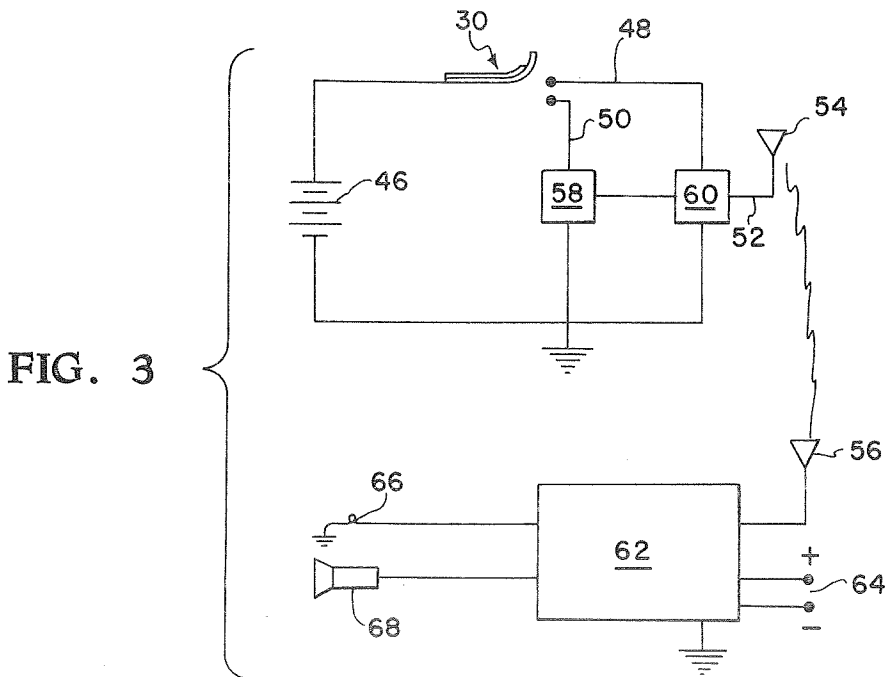


FIG. 3

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3,491,335  
**EXCESSIVE TEMPERATURE  
WARNING SYSTEM**

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Administration

Continuation-in-part of application Ser. No. 550,083,  
May 11, 1966. This application Nov. 26, 1968, Ser.  
No. 784,521

Int. Cl. B60q 1/00; G08b 1/08  
U.S. Cl. 340-57 7 Claims

**ABSTRACT OF THE DISCLOSURE**

This disclosure concerns a warning system for indicat-  
ing excessive tire temperature in vehicles having pneu-  
matic tires. One species features a remote radio trans-  
mitter activated by a coulomb damped bimetallic tem-  
perature sensor and broadcasting a two-staged warning  
signal. The other species utilizes a bellows heat sensor to  
control the action of a noisemaker device.

**CROSS REFERENCES TO RELATED  
APPLICATIONS**

This application is a continuation-in-part of Ser. No.  
550,083, filed May 11, 1966, now abandoned.

**ORIGIN OF THE INVENTION**

The invention described herein was made by an em-  
ployee of the United States Government and may be  
manufactured and used by or for the Government for  
governmental purposes without the payment of any royalti-  
es thereon or therefor.

This invention relates generally to a warning system  
and more particularly to a warning system for operators  
of large aircraft or land vehicles of impending danger  
arising from excessive wheel temperatures.

In the past various devices have been utilized to signal  
either the pressure or temperature of wheels in various  
vehicles. For example, the use of a whistle attached to  
a valve stem in cooperation with the tire pressure has  
been known to provide an audio signal when the tire  
pressure exceeded a designated amount. Other devices  
such as flags that extend from the wheel when the critical  
pressure or temperature point is approached have been  
used, as well as systems wherein the temperature is utilized  
to govern or control a pressure system that is linked with  
a whistle in the control center of the vehicle being oper-  
ated. Each of these latter devices requires that the sys-  
tem be closed. That is, there must be a pressure or elec-  
trical line between the sensor at the wheel and the opera-  
tion center. Such systems are cumbersome and require a  
large number of components which can substantially  
reduce system reliability.

Obviously, many of the prior art devices are incapable  
of providing a continuous monitoring of the wheel tem-  
perature while keeping the operator apprised of the situ-  
ation. Especially is this true with wheels on the high per-  
formance aircraft of the present day. The wheels of  
modern aircraft at times during flight encounter extreme  
temperatures which could cause a failure of the wheel  
without the pilot or operator having knowledge that the  
tire had failed and would cause an accident on landing.

In order to overcome the disadvantages of the prior  
art, the instant invention contemplates the use of a tem-  
perature sensor which can be utilized to energize a trans-  
mitter that emits a signal to a remote receiver for activa-  
tion of a warning device.

It is an object of the instant invention to provide a

warning system for operators of large vehicles of impend-  
ing danger from overheating of the wheels.

Another object of this invention is to provide a light-  
weight miniature warning system that continuously moni-  
tors a potentially hazardous condition and signals a remote  
location when the condition exceeds predetermined limits  
while avoiding positive connection between the two loca-  
tions.

A further object of this invention is to provide a sensor  
for energizing circuits that respectively establish the  
frequency of signals to be emitted from a transmitter to  
a remote receiver that controls warning devices.

Still another object of the instant invention is to pro-  
vide a warning system in which a temperature sensor  
controls a transmitter that emits a signal to a remote  
receiver for activating a warning device which indicates  
the existing condition of a potentially hazardous device.

A still further object of this invention is to provide  
a sensor, transmitter and antenna with connecting cir-  
cuitry therefor on a wheel to emit a signal, determined  
by the temperature of a wheel, that is received by a  
receiver that activates a warning device near the operator  
of the vehicle.

Generally, the foregoing and other objects are accom-  
plished by utilizing a bimetallic sensor which moves in  
accordance with the temperature on the wheel to which  
it is attached to close, respectively, a primary and a  
secondary circuit which cause a transmitter to be ener-  
gized and emit a signal. The signal emitted depends upon  
whether the secondary circuit has been energized at the  
time the primary circuit is energized. Closing of the  
primary circuit energizes the transmitter that emits a  
signal of predetermined frequency. Excessive temperatures  
sensed by the bimetallic sensor cause the secondary cir-  
cuit to be closed which energizes a subcarrier oscillator  
to modulate the signal and algebraically add the fre-  
quencies of the transmitted signal. The receiver at the  
remote location picks up the signals and when only  
moderate temperatures have been sensed at the wheel, the  
receiver activates a warning light. When excessive tem-  
peratures are encountered at the wheel and the second-  
ary circuit closed, the receiver picks up the modulated  
signal and activates a warning speaker.

A more complete appreciation of the invention and  
many of the attendant advantages thereof will be readily  
apparent as the same becomes better understood by refer-  
ence to the following description when considered in  
connection with the accompanying drawings wherein:

FIG. 1 is a partial elevational view of a wheel incor-  
porating one embodiment of the instant invention;

FIG. 2 is an enlarged and partial sectional view of a  
portion of FIG. 1;

FIG. 3 is a schematic circuit diagram of an embodi-  
ment of the instant invention; and

FIG. 4 is a partial cross-sectional elevational view of  
another embodiment of the instant invention.

Referring now to the drawings and more particularly  
to FIG. 1 wherein wheel 12 is shown to have tire 14  
mounted thereon for rotational movement about axle 16.  
Wheel 12 is supported from axle 16 by hub 18 and spokes  
20 or any other conventionally known structure.

Monitor 30 is mounted on wheel 12 on the interior side  
thereof and, FIG. 2, includes casing 32 surrounding open-  
ing 34. Bimetallic heat sensor 36 is attached to wheel 12  
by conventional means (not shown) and includes a least-  
susceptible-to-heat portion 38 and the most-heat-sensitive  
portion 40. As shown in FIG. 2, the end of the bimetallic  
sensor is curved and engages the casing 32, to provide  
frictional or coulomb damping so that random vibrations  
impressed on the sensor by the wheel will not falsely trig-  
ger the warning signal. The sensor 36 is also mounted so  
that centrifugal forces will override the temperature-in-

duced movement of the sensor 36 at high rotational speeds, to prevent insidious warnings to the pilot when he is at the point of takeoff. Stop 42 prevents sensor 36 from being forced into more intimate contact with wheel 12 by rotational forces during high speed rotation of wheel 12. As will be described hereinafter, it is necessary to utilize a power source, such for example as battery 46, in order to energize primary circuit 48 and secondary circuit 50.

Referring now to FIG. 3 wherein a block diagram of an embodiment of the instant invention is shown to include primary circuit 48 which is the initial circuit closed to permit electrical power from battery 46 to flow to and activate transmitter 60. Antenna 54 is connected to transmitter 60 by antenna lead 52. When the portion of sensor 30 in intimate contact with wheel 12 senses excessive temperature, bimetallic sensor 36 arches further and secondary circuit 50 is closed to permit battery 46 to energize subcarrier oscillator 58 which modulates the signal emitted from transmitter 60. Subcarrier oscillator 58 and transmitter 60 are of conventional construction and are well known in the miniature electronics field. It is to be noted from FIG. 1 that a preferable arrangement for the sensor, battery transmitter and subcarrier oscillator are on opposed sides, that is, diametrically opposite one another in order to balance wheel 12. An example of the frequency transmissions of the subcarrier oscillator 58 and transmitter 60 might be in the range of two kilocycles for subcarrier oscillator 58 and 250 megacycles for transmitter 60. These signals would be transmitted through antenna 54 to a remote location as will be described more fully hereinafter.

As indicated in FIG. 3, the remote location would require antenna 56 connected with FM receiver 62 to pick up the signal emitted from transmitter 60. Receiver 62 is powered by source 64 and is connected with warning light 66 and audio warning signal 68.

Referring now to FIG. 4 wherein an alternative embodiment of the instant invention is shown to include bellows heat sensor 70 attached to force rod 72 pivoted at 74 to lever 76. Lever 76 in turn is pivoted at 78 adjacent counter balance 80. The opposite end of lever 76 has resilient stop 82 mounted thereon for a purpose that will become apparent hereinafter. Adjustable stop 84 is secured to counterbalance 80 to prevent link 86, which is pivoted at 88 to bracket 92, from being prematurely released to activate noisemaker 100. Bracket 92 is mounted on wheel 12 by bracket base 94 which includes link arm 96 to which link 86 is pivoted at 88 and lever arm 98 for attachment of lever 76 about pivot 78.

#### OPERATION

The embodiment of the invention shown in FIGS. 1-3 may be utilized on aircraft or large articulated land vehicles in order to warn the operator thereof when the wheels or tires are encountering excessive temperatures. For example, wheel 12 is immediately adjacent the brake drums which generally create the greatest amount of heat. Bimetallic strip 36 is in intimate contact along a portion of its length with wheel 12 which contacts the inner tube or air in the tire. The main source of heat, the brake, is generally the cause of the high wheel temperatures and results in high tire temperature which may cause many accidents. In any event, the wheel, due to its intimate contact with the tire, is indicative of tire temperature, and, therefore tire pressure.

At moderate temperatures, bimetallic strip 36 bends under the action of the heat of wheel 12 and closes primary circuit 48. When circuit 48 is closed, transmitter 60 is energized and causes a signal to be sent to receiver 62 in, for example, the cockpit via antenna 54 and 56. Upon receipt of the signal, receiver 62 energizes a warning light 66 on the pilot's instrument panel. If bimetallic sensor 36 senses excessive temperatures, it will advance further with the increase in temperature to energize circuit 50

and subcarrier oscillator 58 which is in that circuit. Subcarrier oscillator 59 modulates the signal emitted from transmitter 60 and received by receiver 62. Receiver 62 which activated light 66, upon receipt of the modulated signal, will activate audio warning signal 68 to thereby warn the pilot or operator of the vehicle that excessive temperatures are present in the wheels and remedial action should be taken.

Referring to FIG. 4, an alternative embodiment of the invention is shown wherein bellows sensor 70 which is in intimate contact with wheel 12 expands when the temperature in the tire increases sufficiently above ambient temperature. Expansion of sensor 70 applies a force to lever 72 to rotate it a small amount in a counterclockwise direction. The counterclockwise movement of lever 76 compresses resilient stop 82 and at the same time adjustable stop 84 is slid from link 86. Thus, it is seen that when the tire temperature has risen sufficiently, link 85 is free to swing clockwise to an outward position such that noise making device 100, for example a whistle, is activated. Obviously, counterbalance 90, because of centrifugal forces, assists in rotating link 86 and noisemaker 100 in a counterclockwise direction. In the inboard position shown in FIG. 4, suitable shields could be utilized to prevent ram air from prematurely activating noisemaker 100.

One aspect of the invention which makes it attractive is the advance state of the art in miniaturization; ruggedness, and shelf life of transmitter and power components. The transmitting and sensing devices lend themselves to being variously located to effect dynamic and static balance of the wheel. Obviously, the monitoring of tire temperature with the above device will warn the pilot or operator when he is using his brakes excessively during taxiing. Also, if the brakes are dragging and causing overheating, he may direct remedial action either to the ground crew before take-off or while in flight where possible. Thus, the instant device will prevent costly tire blowouts and wheel failures in the operation of aircraft or articulated land vehicles and thereby avoid catastrophic accidents. The device may also be of considerable use as a research tool in obtaining data regarding vehicle safety.

Obviously, many modifications and variations of the subject invention are possible in light of the above teachings. For example, a thermistor or button-type thermostat could be used to open and close the circuits to the transmitter and batteries or through the proper circuitry to provide a continuous reading of the temperature of the wheel.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a warning system, the combination comprising: a wheel having transmitter means for broadcasting signals to a remote location; means for sensing the temperature of said wheel mounted thereon; control means responsive to said sensing means to cause said transmitter to broadcast a first signal when the temperature of said wheel reaches a first level and a second signal upon reaching a higher level; receiver means to receive said first and second signals and produce a sensory output in response to each of said first and second signals, whereby first and second sensory outputs are produced successively upon continued heat buildup in said wheel.
2. The warning system of claim 1 wherein said sensing means comprises a bimetallic strip and said control means includes primary circuit means closed by said strip sensing moderately high temperatures of said wheel; and secondary circuit means closed by said strip sensing extreme temperatures of said wheel whereby said transmitter means is respectively activated by said primary and

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secondary circuits to broadcast a combination of signals to a remote location.

3. The warning system of claim 2 wherein said secondary circuit means includes miniature subcarrier oscillator means for modulating the signal from said transmitter means to said remote receiving means.

4. The warning system of claim 3 wherein said transmitter means and said receiving means include antenna means mounted on said wheel and at said remote location, respectively; a miniaturized power supply mounted with said strip on said wheel opposite said transmitter means to maintain the balance of said wheel; and a second power supply connected with said remote receiving means.

5. In a warning system, the combination comprising:  
a wheel mounted for rotation about its axis, heat sensor means producing a force tending to produce movement of an output member in response to temperature increases of said wheel;

means mounting said output member on said wheel with respect to said axis so that centrifugal forces are created tending to oppose said heat sensor means forces;

output means creating a sensory output in response to movement of said output corresponding to excessive temperatures and a predetermined angular velocity of said wheel, whereby a sensory signal indicating excessive wheel temperatures is provided at a desired wheel angular velocity.

6. A warning system comprising:  
a wheel mounted for rotation about its axis;

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a bimetallic heat sensor element mounted in cantilevered fashion to said wheel;

indicator means providing a sensory output in response to a predetermined movement of the free end of said cantilevered element;

damper means providing damping of the free end of said element, whereby said sensory output will be produced solely by temperature-induced movement of said element and not by vibrations impressed thereon by said wheel.

7. The system of claim 6 wherein said damper means includes a curved portion formed on the free end of said element and a relatively fixed surface frictionally engaging said curved portion to produce coulomb damping while allowing movement of said element.

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U.S. Cl. X.R.

200—61.22; 337—1; 340—224, 227.1